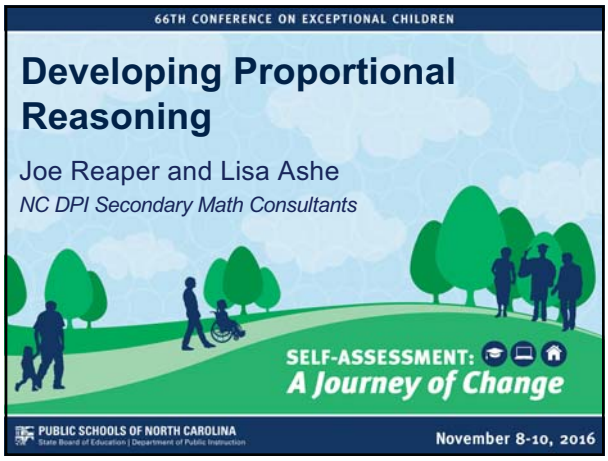

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Goals of the PD

- To understand the importance of middle school mathematics in the development of college and career readiness.
- To build a coherent understanding of the development of mathematical concepts through middle school by focusing on the conceptual development of multiplicative relationships.

Importance of MS Math

"The evidence concerning college and career readiness shows clearly that the knowledge, skills and practices important for readiness include a great deal of mathematics…some of the highest priority content for college and career readiness comes from grades 6-8."

Jason Zimba (2011)

Ratios and Proportional Reasoning

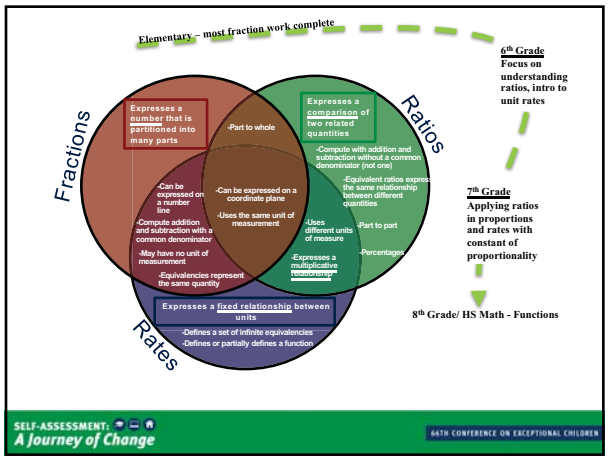
Always, Sometimes, Never

1. You are to complete this activity as a table group.
2. Take turns selecting and reading a card giving each person an opportunity to read a card.
3. Decide as a group to place the card into the Always, Sometimes, or Never column.
4. Continue until all the cards are placed or time is called.
5. Be prepared to discuss your group's reasoning for the placement.

Fractions and Ratios

Two out of the five apples are rotten.

If I mathematically represented this statement as $\frac{2}{5}$, would this represent a fraction or a ratio?


Elementary – most fraction work complete
6th Grade
Focus on understanding ratios, intro to unit rates
7th Grade
Applying ratios in proportions and rates with constant of proportionality
8th Grade/ HS Math - Functions
Fractions
Ratios
Rates
Expresses a number that is partitioned into many parts
Expresses a comparison of two related quantities
Expresses a fixed relationship between units
-Part to whole
-Can be expressed on a number line
-Can be expressed on a coordinate plane
-Uses the same unit of measurement
-Compute addition and subtraction with a common denominator
-May have no unit of measurement
-Equivalencies represent the same quantity
-Compute with addition and subtraction without a common denominator (not one)
-Equivalent ratios express the same relationship between different quantities
-Uses different units of measure
-Part to part
-Percentages
-Expresses a multiplicative relationship
-Defines a set of infinite equivalencies
-Defines or partially defines a function
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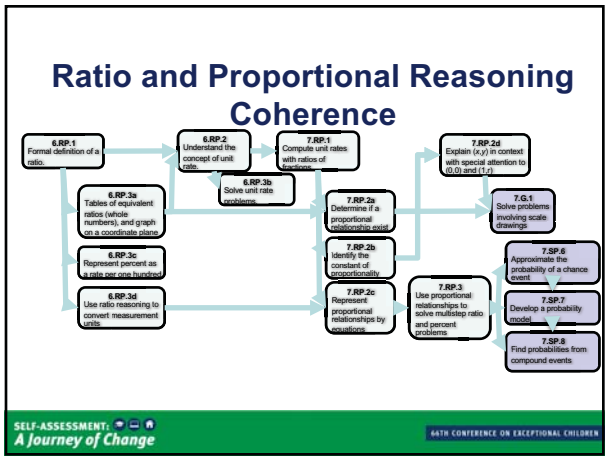
Ratio and Proportional Reasoning Coherence
6.RP.1 Formal definition of a ratio.
6.RP.2 Understand the concept of unit rate
7.RP.1 Compute unit rates with ratios of fractions
6.RP.3b Solve unit rate problems
6.RP.3a Tables of equivalent ratios (whole numbers), and graph on a coordinate plane.
6.RP.3c Represent percent as a rate per one hundred
6.RP.3d Use ratio reasoning to convert measurement units
7.RP.2a Determine if a proportional relationship exist
7.RP.2b Identify the constant of proportionality
7.RP.2c Represent proportional relationships by equations
7.RP.2d Explain (x,y) in context with special attention to (0,0) and (1,r)
7.G.1 Solve problems involving scale drawings
7.RP.3 Use proportional relationships to solve multistep ratio and percent problems
7.SP.6 Approximate the probability of a chance event
7.SP.7 Develop a probability model
7.SP.8 Find probabilities from compound events
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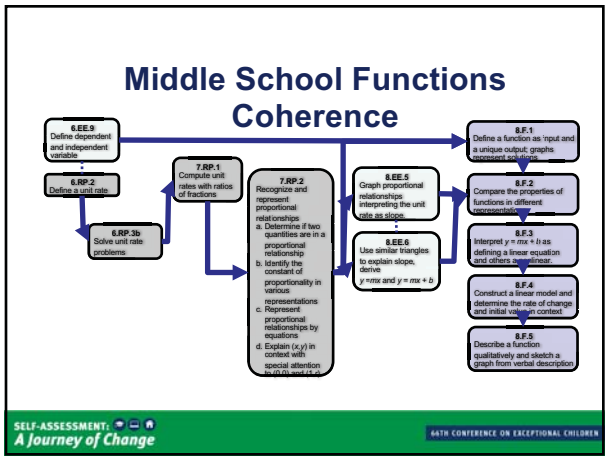
Middle School Functions Coherence
6.EE.9 Define dependent and independent variable
6.RP.2 Define a unit rate
6.RP.3b Solve unit rate problems
7.RP.1 Compute unit rates with ratios of fractions
7.RP.2 Recognize and represent proportional relationships
a. Determine if two quantities are in a proportional relationship
b. Identify the constant of proportionality in various representations
c. Represent proportional relationships by equations
d. Explain (x,y) in context with special attention to (0,0) and (1,r)
8.EE.5 Graph proportional relationships interpreting the unit rate as slope
8.EE.6 Use similar triangles to explain slope, derive y=mx and y = mx + b
8.F.1 Define a function as 'nput and a unique output; graphs represent solutions
8.F.2 Compare the properties of functions in different representations
8.F.3 Interpret y = mx + b as defining a linear equation and others are nonlinear.
8.F.4 Construct a linear model and determine the rate of change and initial value in context.
8.F.5 Describe a function qualitatively and sketch a graph from verbal description
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Equivalent Ratios

Before we jump into ratios… lets start out with some skill development.

Using Multiplication and Division...
How can you change 8 to 12?

16 to a 6?

3 to a 4?

Equivalent Ratios

In 6th grade, the focus for standard 6.RP.3a is on creating and recognizing equivalent ratios.

This is fundamental for working with proportions in 7th grade.

Example: 3 out of every 4 win a prize at the fall festival at a game.

Create 5 equivalent ratios of 3 to 4.

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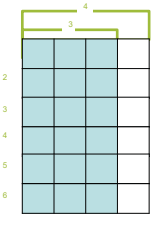
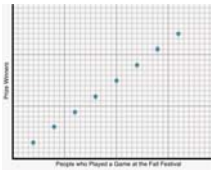


Ratio Table

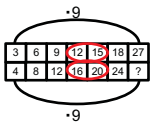
3	6	9	12	15	18
4	8	12	16	20	24

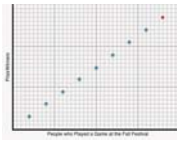
winners
players



If 27 people won a prize, how many played the game?

Ratio Table





If 27 people won a prize, how many played the game?

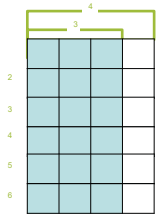
Within: unit rate (common to all equivalent ratios)

3	6	9	12	15	18	27	winner
4	8	12	16	20	24	36	players

Between: scale factor (unique to each pair of equivalent ratios)

Important notes about the ratio table:
There exist a relationship **between** and **within** equivalent ratios that must be maintained.
Students need to be able to identify these.

Example Revisited: Create 5 equivalent ratios of 3 to 4.



Ratio Table

3	6	9	12	15	18	27
4	8	12	16	20	24	?

How are ratios different from fractions?

The Unit Rate and Measurements

Two exchange students are coming to your school. Their profiles show that Tomas is 155 cm tall and Rokas is 170 cm tall. How many inches taller is Rokas then Tomas? (1 inch is approximately 2.5 cm.)

Student Strategies with Ratio Tables:

Student 1:	2.5 cm	5 cm	15 cm
	1 in	2 in	6 in

Student 2:	2.5 cm	25 cm	5 cm	15 cm
	1 in	10 in	2 in	6 in

Student 3:	2.5 cm	25 cm	150 cm	5 cm	155 cm	170 cm
	1 in	10 in	60 in	2 in	62 in	68 in

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The Unit Rate and Measurements

Your basketball team is traveling to Europe and you need to find their heights in *cm* for the game program. Write an equation you can use in this situation.
(Let c represent length in centimeters and i represent length in inches.)

$c = 2.5i$ $i = 2.5c$

$c = i + 3$ $i = c$-1.5

2.5 cm	5 cm	15 cm
1 in	2 in	6 in

Which relationship, within or between, is necessary for writing an equation? Explain your reasoning.

According to the situation, which variable should be the independent variable (input)?

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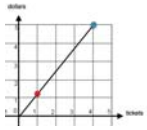
The Unit Rate

In a school fundraising raffle, you can get 4 tickets for $5. What is the cost per ticket?

Will this be more or less then $1?



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The Unit Rate

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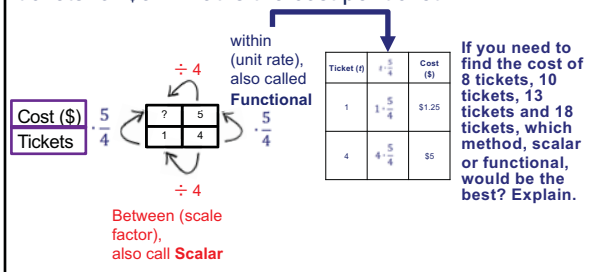


If you need to find the cost of 8 tickets, 10 tickets, 13 tickets and 18 tickets, which method, scalar or functional, would be the best? Explain.

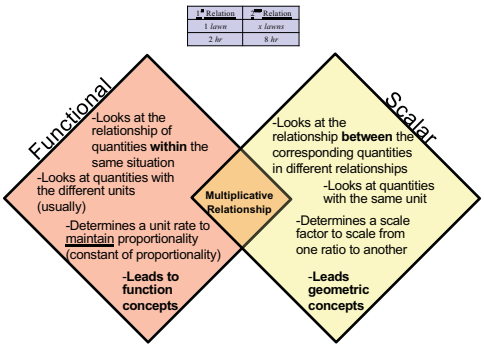
Proportional Language

FUNCTIONAL

- The relationship of two **values** in the **SAME** measure space.
- We utilize this internal **multiplicative relationship** to *maintain proportionality* and/or similarity.

SCALAR

- The relationship of the values from two **DIFFERENT** measure spaces.
- We utilize this corresponding **multiplicative relationship** to move between different SCALES or to extrapolate from one situation to another.



Proportions

Maggie is working from a blueprint in which 3 inches represents 14 feet. Write an equation that represents the relationship between the actual lengths (a), in feet, and the blueprint lengths (b), in inches?

$b \cdot \frac{14}{3} = a$ $\quad$ $a \cdot \frac{3}{14} = b$

When would you want to use one equation over the other?

Proportions

In a group of 4, pass out a card of the "Time to Bake" problem to each person.

Individually read your card and determine if you can answer the question. If you cannot, what information do you need?

As a group, each person talk about the question and information from your card. The group will decide a course of action to answer the question based on the information from the cards.

When you finish, a 5th card will be given to your group to complete the task.

Implement tasks that promote reasoning and problem solving.

Student learning is greatest in classrooms where the tasks consistently encourage high-level student thinking and reasoning and least in classrooms where the tasks are routinely procedural in nature.

(Boaler & Staples, 2008; Stein & Lane, 1996)

Implement tasks that promote reasoning and problem solving.

Mathematical tasks should:

- Allow students to explore mathematical ideas or use procedures in ways that are connected to understanding concepts.
- Build on students' current understanding and experiences.
- Have multiple entry points.
- Allow for varied solution strategies.

Boaler & Staples, 2008; Hiebert et al., 1997; Stein, Smith, Henningsen, & Silver, 2009

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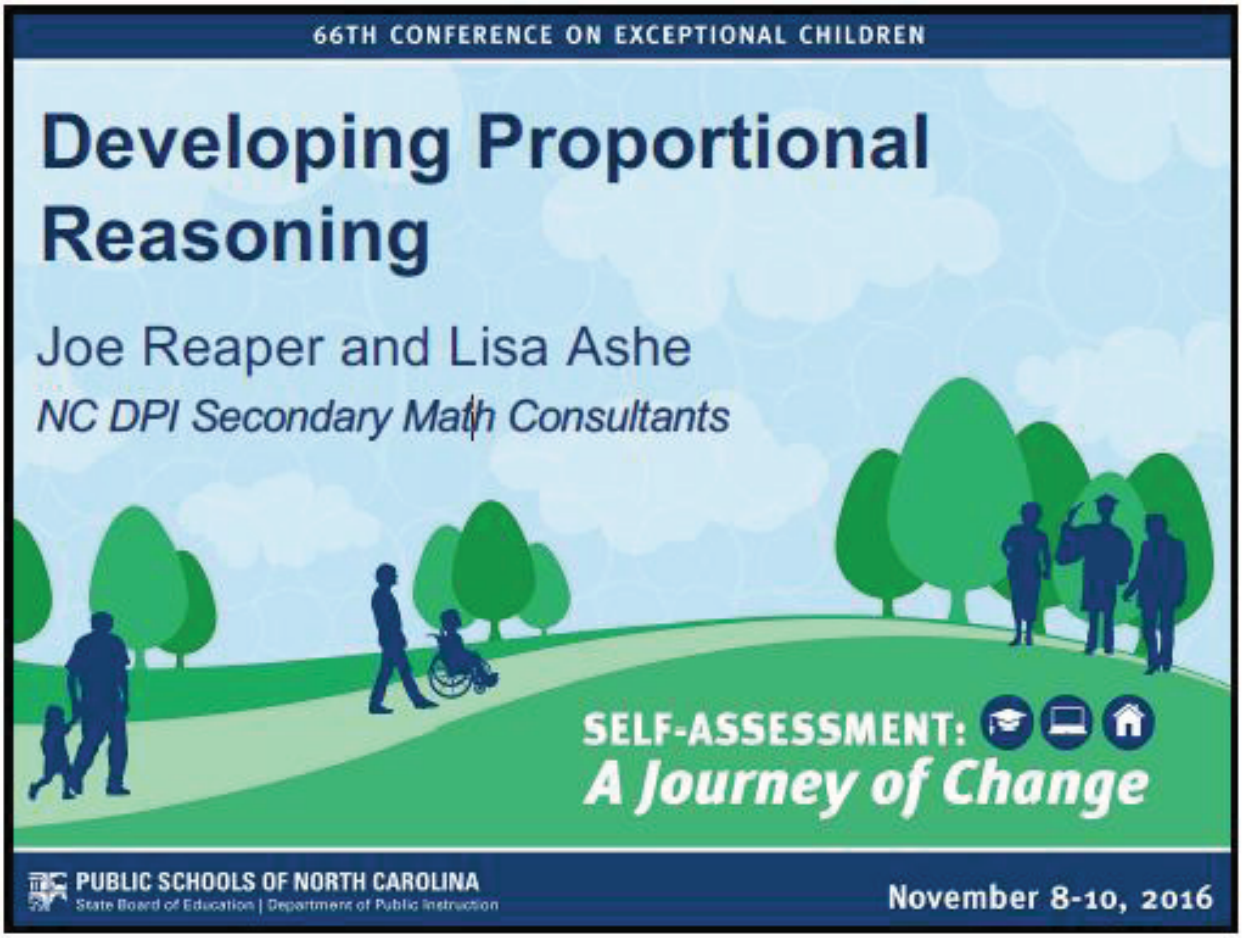

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